Chapter 7
Operating Equipment

7-1. General

The operating equipment for vertical lift gates is referenced here for general description. Design criteria for operating machinery will be provided in EM 1110-2-2610 to be published. Interim guidance is provided by contacting CECW-E and in EM 1110-2-2703 and EM 1110-2-4205.

7-2. Types of Hoists

Vertical lift gates use hydraulic or wire rope hoist systems. Wire rope hoists are used for spillway crest, outlet, and navigation lock gates. They are more suitable for gates that have deep submergence requirements, applications that do not allow portions of hydraulic cylinders above the deck (shallow settings), or when hoisting loads are too large and economics makes hydraulic cylinders impractical, as in vertical lift gates in navigation locks.

a. Wire rope hoists. Wire rope hoists consist of drums and a system of sheaves and blocks that are driven through a motor and arrangement of shafts, speed reducers, and spur or helical gears. Motors may be electric or hydraulic driven. It is common to provide two speeds to permit lowering at approximately twice the raising rate. The hoisting equipment is normally located next to the gate or slot with controls located in the control room, governor control cabinets, or next to the navigation lock gate depending on the gate and its intended use.

(1) Bull wheels. Bull wheels are used in overhead lift gates as a friction drive for hoisting the gate. The bull wheel, motor, and gearing system are located in a tower, high enough to raise the gate to its full and open position. The wire ropes wrap over the top of the bull wheel in grooves, with one side of the wire ropes connected to the gate and the other end to a counterweight. The motor and gear system provide the mechanical effort required to hoist the gate. This type of drum system is advantageous when the hoisting loads are large.

(2) Counterweights. These are used mainly in overhead type gates to offset the dead load of the gate to minimize the hoisting effort. The weight of the vertical lift gate will determine the mass of the counterweight required. It should be designed to compensate for adjustment of its mass to calibrate it with the weight of the gate once the system is in place. It is normal to have the gate/counterweight slightly unbalanced to allow the gate to close without power. Another method for reducing the lifting effort is with a series of drums and sheaves, which are selected to give the mechanical advantage desired.

(3) Motors and gear boxes. Motors and gear boxes are the primary drives for wire rope hoist systems. Guidance for design may be obtained from sources referenced in paragraph 7-1. In addition, gear box components should follow the general guidance from the American Gear Manufacturers Association (AGMA) (1997).

(4) Wire ropes and sheaves. Selection, installation, maintenance, and inspection requirements for wire ropes and sheaves are contained in a draft EM, “Wire Rope Selection Criteria for Gate Operator Devices.”

b. Hydraulic hoists. Hydraulic hoists normally consist of a single acting cylinder, pumps, reservoir, controls, and piping. More recent applications use telescoping cylinders to accommodate deep submergence gates. One or two cylinders may be used, the number of which is determined by the hoisting requirement and economics. The arrangement may include the cylinder to be supported above the gate with the gate and cylinder rod hanging from the piston or the cylinder recessed within the gate.

c. Roller chain hoists. Roller chain hoists consist of the lifting chain, drive and idler sprockets, drive machinery, and counterweight. The roller chains are located in recesses in the lock wall. Roller chains are flexible about an axis parallel to the lock center line and rigid about an axis perpendicular to the lock center line. Near the top of each recess the lifting chain is redirected by an idler sprocket to the drive sprocket, which is located in a recess below the top of the lock wall. From the drive sprocket the lifting chain continues to a second idler sprocket at the top of a counterweight chase. From the second idler sprocket the lifting chain extends vertically to the counterweight. The chain connection to the gate leaf is a three-dimensional gimbal, which allows rotation about the axes both parallel and perpendicular to the lock center line. Rotation of the connection point is allowed to prevent the lifting chain from being bent about its rigid axis when the gate leaf rotates. The connection points on the gate should be located at the end portions, at the approximate center of gravity of the gate. The drive machinery, located in a watertight recess at the top of the lock wall, consists of electric motor, open gear sets, and reducers. An advantage of roller chains is the positive drive connection over the drive sprocket, which does not require the space of a cable drum. Disadvantages include relative high cost of chains, frequent maintenance for lubrication, corrosion, and critical alignment required between sprockets.

7-3. Dogging Devices

Dogging devices (dogs) are usually mounted on grillages in recesses in the piers opposite the end posts of the gate. They pivot to permit retraction for clearance of the gate and are operated with push rods. Two or more dogs at each end of the gate slot may be required. The number and location of the dogs are determined by the operating requirements for discharge regulation and gate storage. The gate sections require dogging seats fabricated with structural or cast steel, welded or bolted on the end posts. The treads of cantilevered wheels may be used as dogging seats. Another type of dogging device consists of a cantilevered mild steel H-beam that retracts inside the gate at each end between the top and second girder web. The beam is located at the center of gravity of the gate in the upstream/downstream direction and runs through the end post to a reaction point at an interior diaphragm. The dogging beam is extended and retracted by using a bar as a manual lever extending through a hole in the top web and into a row of holes in the top of the dogging beam. The cantilevered end of the beam rests on bearing pads recessed in the piers. This type of dogging device is preferred for powerhouse gates and bulkheads since they can also be dogged at the intake or draft tube deck level and there are no mechanical devices to be lubricated or maintained. Dogging devices should be designed to support twice the calculated dead load to allow for impact.

7-4. Lifting Beams

Lifting beams are normally provided for outlet gates and maintenance bulkheads. Because these gates are normally stored in a submerged condition, the lifting beam provides a latching and unlatching mechanism to lift the gate from the slot. Design guidance for lifting beams can be found in EM 1110-2-4205.